

5 DYNAMIC SECURITY CREDENTIAL GENERATION SYSTEM AND METHOD

Field Of The Invention

The invention relates generally to security credential creation systems and  
10 methods and more particularly to systems and methods that create cryptographic keys for  
subscribers.

Background Of The Invention

15 In typical public key cryptographic systems, digital signature key pairs (a private  
key and a public key) are used to authenticate a digital signature of a subscriber to ensure  
that a message sent by a subscriber actually came from the subscriber sending the  
message. In addition to digital signature key pairs, encryption key pairs are also  
generally used to encrypt the data being sent from one subscriber to another subscriber.  
20 Certificates are generated by a trusted certification authority for the public keys of the  
private/public key pair to certify that the keys are authentic and valid. The public keys  
and certificates are used for two main purposes: verifying digital signatures and  
encrypting information. Such a system is a two key pair system. The receiver of a  
digitally signed e-mail or documents for example, uses the public key in the sender's  
25 verification certificate to verify the digital signature of the sender. A user wishing to  
send encrypted e-mail first encrypts the e-mail with a random symmetric key, then uses  
the intended receiver's public encryption key to encrypt the symmetric key and then  
attaches the encrypted symmetric key to the encrypted e-mail so that the receiver can  
decrypt the e-mail.

Hence, a subscriber (e.g., node, standalone unit, software application or other suitable entity) sending a message sends the data with its digital signature along with a certificate. The certificate has the certification authority signature. A receiver validates the digital signature in the received certificate. Each subscriber stores a certification authority public key to verify that the certificate was signed by the certification authority. A digital signature certificate typically includes a user public key, a user name and a signature of the certification authority. Each sender has a copy of its own certificate. To send an encrypted message, a sender accesses a directory, such as an onboard subscriber cache memory or other certificate storage medium to get a copy of the encryption certificate for a specified receiver (other subscriber).

Some information security systems that are public key based systems, support one key pair, wherein the one key pair is used to both encrypt information and to apply digital signatures. Other information security systems use the two key pair approach as indicated above. A three key pair approach has been proposed in Secured Electronic Information Society paper entitled "Seis-S10-Seis Certificate Policy, High Assurance General Id Certificate With Private Key Protected In An Electronic Id Card, Version 1.0". This three key pair approach defines one key pair to be used as an encryption key pair for key encipherment, one key pair is used as an authentication key pair is used for digital signatures and the third key pair is used for non-repudiation usages (e.g., digital signatures having longer lives). However, with all of these known approaches, such systems typically support only a fixed number of keys or key pairs and/or fixed types of key pairs.

For example, conventional public key cryptography systems and other cryptographic systems allow the replacement of a symmetric key or public key pair when the key expires, but typically only the same type of key pair or key is allowed to be used. Where a new key pair is desired, such as when a key pair expires, there typically needs to be an out of band communication to ensure that the critical keys are not obtained by an unscrupulous party. As such, there are typically manual processes for generating and transferring key information.

When an additional key pair is required (rather than the replacement of an existing key), new application software has to typically be loaded that can accommodate a different security structure having a different number of key pairs since applications typically are hard coded to accommodate a specific cryptographic approach. Changes required to allow a subscriber to interface with another subscriber or management server having a different number of key pairs or a different number of keys, generally require the systems to be shut down and reinitialized with new codes to allow the subscribers to be cryptographically compatible. With a greater number of information security infrastructures available, it would be desirable to have a system that can support the dynamic variation of the number of keys (e.g., symmetric keys) or key pairs to allow N key pairs and associated credentials to be automatically generated without reinitializing a subscriber. Hence, it would be desirable if there was a system that allowed a subscriber, such as a software application or processing unit, to perform an initial log in with existing security credentials and dynamically update the existing credentials set by, for example, adding additional key pairs and/or different types of key pairs.

Inter-operability problems arise between infrastructures using dual key pairs and infrastructures using one key pair. In addition, it can be difficult to enhance security architectures around a fixed number of key pairs when it is desired to increase the number of fixed key pairs. Typically, the number of key pairs are fixed, but the actual key pairs may be revoked and new key pairs may be issued for the same purpose. These may be generated through an off-line generation technique. As known in the art, additional security credential information is used with key pairs such as the public key certificates.

In addition, Internet browsers are known which allow adding key pairs and the maintenance of key pairs by using a list of key pairs where each key pair is typically dedicated to one CA. Also, a user has to request each key pair from each certificate generator or service provider. For each certification authority to which a browser enrolls, a key pair is generated and a certificate is registered and issued.

Consequently, a need exists for an improved information security system that can dynamically create security keys for subscribers that already have a preexisting security credential set.

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### Brief Description Of The Drawings

The below-described invention will be more readily understood in view of the described drawings.

10 FIG. 1a is a block diagram illustrating one embodiment of an apparatus for facilitating dynamic creation of security keys for a subscriber having at least one previously existing security credential set in accordance with one embodiment of the invention.

15 FIG. 1b is a graphic illustration of a configured key manifest in accordance with one embodiment of the invention.

FIGS. 2a and 2b illustrate a flow chart of one example of the operation of the system shown in FIG. 1a.

### Detailed Description Of The Preferred Embodiment

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Briefly, an apparatus and method for dynamically creating security keys for a subscriber, having at least one pre-existing security credential set, allows the configuration for N key pairs or N keys (where the cryptographic system is a symmetric key system). Such a system provides flexibility in assigning cryptographic algorithms and cryptographic keys to facilitate a change in algorithm without requiring re-  
25 initialization of a processing unit or subscriber. In addition, there can be a change in signing algorithm from message to message, for example. The apparatus and method provides a configurable security key manifest, such as a template or table, operative to contain a non-prespecified number of security keys. A security officer or other source  
30 may input key configuration data to a graphic user interface template or other suitable mechanism to configure the security key manifest. Once configured (populated), the

apparatus dynamically controls the generation of at least one new security key for the subscriber based on received key attribute data and based on the differences in current and prior security key manifests.

5 One example of a configured security key manifest may include, for example, a key pair manifest (or a symmetric key manifest) which may be a list of key pair records. Each record contains information about a class of key pairs and attributes for each key pair. The manifest is in effect an indication from a key manifest generator's point of view as to what collection of key pairs, or keys, a subscriber should have. The manifest is  
10 maintained on a per user basis, per application basis, per group basis, or any other suitable basis.

In one embodiment, a key manifest generator generates an updated security key manifest, such as a configured key manifest, and digitally signs the key manifest and  
15 publishes it in a repository which may be accessed by a suitable subscriber. The subscriber compares the updated security key manifest after verifying the digital signature and compares it to the preexisting credential set of the subscriber. Where there is a difference between the updated security key manifest and the preexisting credential set for a given application or subscriber, the subscriber updates the preexisting credential  
20 set based on the comparison by, for example, generating an additional key pair if the updated security key manifest indicates that the subscriber must have a different number or types of key pairs.

FIG. 1a illustrates an example of an apparatus 10 which facilitates dynamic  
25 creation of security keys for a subscriber 12 where the subscriber has a preexisting cryptographic security key as part of preexisting security credentials 14. The subscriber 12 may be any suitable processing unit, software application or other entity which requires security credentials to provide information security. For example, the apparatus 10 may be incorporated in a public key cryptography system, symmetric key  
30 cryptography system or any other suitable system. For purposes of describing the invention, the apparatus 10 will be assumed to be in a public key-based cryptography

system. When applied to such a system, the preexisting security credentials may include, for example, a dual key pair set of an encryption pair and signing key pair as known in the art. Preexisting security credentials may include, in addition to a cryptographic security key or key pair, certificate information and other suitable security related information if desired. The preexisting security credentials may be stored in onboard RAM, an offboard hardware token or in any other suitable location. In any event, the subscriber has a preexisting security credential set 14.

The apparatus 10 also includes a key manifest generator 16 which may be a suitably programmed server, or other suitable processing unit. A key manifest generator 16 provides a configurable security key manifest operative to contain a non-prespecified number of security keys. By way of example, the configurable security key manifest may be a configurable security key manifest template presented through a graphic user interface. The configurable security key manifest receives new key attribute data through the configurable security key manifest template. The new key attribute data may be input, for example, through a keyboard or touch screen by a security officer. New key attribute data may include, for example, data representing a number of key pairs for a given subscriber, the key size for each key in the pair, data representing key usage such as whether the key pair is used for encryption, digital signature, nonrepudiation, or some other usage, key maintenance data (e.g., attributes), such as whether or not the keys are to be backed up and if so, whether they shall be backed up at a central authority or other location, which cryptographic algorithm should be used for the encryption process, subscriber identification data identifying which subscriber the new key attribute data is for, and authentication data, such as a digital signature of a trusted authority such as a key manifest generator, or any other suitable attribute information. Once the new key attribute data is accepted, a configured security key manifest 20 is formed containing the new key attribute data.

The configured security key manifest 20, may be stored by the key manifest generator 16 in a suitable repository 22 or otherwise provided to the appropriate subscriber. The configured security key manifest may be stored to be pushed to one or

more subscribers or stored so that it may be pulled or otherwise accessed by one or more subscribers.

The apparatus 10 also includes at least one security key manifest analyzer 24  
5 operatively coupled to obtain the configured key manifest 20, and a security credential  
generator 26 operatively coupled to the security key manifest analyzer 24. The security  
key manifest analyzer 24 receives a preexisting security credential set 14 and analyzes  
the configured security key manifest 20 to determine a difference in key attributes among  
the key attributes in the preexisting credential set and the key or attribute data in the  
10 configured security key manifest 20. The delta ( $\Delta$ ), or difference in attributes data 30  
serves as input to the security credential set generator 26. The security credential set  
generator 26 dynamically generates at least one new security key for the subscriber based  
on the received key attribute data contained in the configured security key manifest 20,  
namely the new key attribute data not already in the preexisting security credential set.

15 The security credential set generator 26 includes a cryptographic key generator,  
such as any suitable public key pair generator or symmetric key generator, operative to  
generate a new public key pair 32, or symmetric key where appropriate, based on the  
content of the configured security key manifest 20. The new public key pair, for  
20 example, then becomes part of an updated credential set 34.

The security key manifest analyzer 24 compares an updated security key manifest  
(i.e., the configured key manifest 20) to the preexisting credential set 14. The preexisting  
credential set 14 contains at least one security key. The security credential set generator  
25 26 facilitates updating a preexisting credential set 14 to generate the updated security  
credential set 34 based on the comparison between the updated security key manifest and  
the preexisting cryptographic credential set.

30 The updated security credential set 34 may be stored, for example, as a list by the  
subscriber in any suitable storage location and serves as the new preexisting credential  
set. The credential set also includes certificates and associated attributes for controlling

other aspects of the subscriber. For example, an original credential set having an RSA signing key and corresponding verification certificate may be updated to also include a DSA signing key and verification certificate, and attributes indicating usage (e.g., for securing email versus a file on disk). As shown by communication link 40 the public key certificate, for example, of a newly generated public key of a newly generated public key pair may be generated by the key manifest generator 16 and sent to the subscriber unit for storage in the updated credential set. However, any suitable communication of the public key certificate, as known in the art, may be used. In addition, alternatively, the security credential set generator 26 may also be located in the server or part of any suitable unit.

The security key manifest analyzer 24 continuously analyzes the configured security key manifest from repository 22 to determine whether another updated configured security key manifest has been published for a given subscriber based on the subscriber ID data into the manifest. As such, it continuously analyzes the content of the configured security key manifest to ensure that configuration information is suitably processed in a timely manner. It will be recognized, however, that continuous analysis may not be needed, for example, where the key manifest generator 16 pushes the configured key manifest to a subscriber or if a subscriber only analyzes the configured key manifest upon notification that an application requires security keys to be used. If desired, no subscriber ID data need be used. In such a case, the security key manifest may be the same for a plurality of subscribers. The key manifest analyzer 24 is used to determine the suitable security keys necessary for a given operation.

Referring also to FIG. 1b, a configured security key manifest is shown as a key pair manifest. However, it will be recognized that a symmetric key manifest or other suitable key manifest may also be used. As shown, the configured security key manifest 20 includes desired new key attribute data 46 for each key pair up to N key pairs. The configured security key manifest 20 includes updated data, mainly key attribute data representing at least one of : key size 48, key usages 50, cryptographic algorithm to be used 52, and other attributes 54, such as key maintenance attributes and authentication data. The configured security key manifest 20 may also include data representing



subscriber identification data 56. For example, key maintenance attributes may be data representing how long to use the keys (key life span).

The key manifest generator 16 includes a digital signer operatively responsive to sign a configured security key manifest. As such, each configured security key manifest 20 preferably includes a digital signature of the key manifest generator that is trusted by the subscriber unit utilizing the configured key manifest information. The key manifest analyzer 24 receives the digitally signed configured security key manifest and passes it through a signature verification engine as known in the art to ensure that the information came from a trusted source and that the information is not otherwise invalid. As such, the digitally signed configured security key manifest may be in the form of a signed certificate such as described in X.509V3. The security key manifest analyzer 24 compares the updated security key manifest (the configured key manifest 20) to the preexisting credential set containing at least one preexisting cryptographic security key.

The security credential set generator 26 facilitates updating of the preexisting credential set by generating a new key if the configured security key manifest indicates that a new key needs to be added. Also, a key may be removed if its attributes do not appear in the configured manifest. As such, input information such as the content of the configured security key manifest may be a local data file, user provided input, data returned in response to a directory query, new data posted to a repository entry, session data received from another party such as a server, or store and forward data received such as by e-mail. The key manifest analyzer determines any differences between the preexisting credential set and the credential set defined by the configured security key manifest. Once a difference is determined, the subscriber, carries out, through the security key generator or any other suitable security credential generating mechanisms, a sequence of actions to acquire new credentials such as giving a new certificate from a third party or generating a self-signed certificate in addition to generating new keys or removing keys. Key credentials may augment the existing set or may entirely replace the existing set. Replacement may be desirable, where existing keys are of a given bit length

that are no longer considered secure or attributes or usages associated with existing keys become obsolete.

Referring to FIGS. 1a - 2b, the apparatus 10 through the processing unit  
5 containing the key manifest generator 16, presents the configurable security key manifest template to a security officer as shown in Block 100. As shown in Block 102, the graphic user interface receives the desired new key attribute data to generate a configured security key manifest. As shown in Block 104, the system generates the configured security key manifest in a proper format for subscribers and digitally signs the configured  
10 security key manifest if desired. As such the system generates an updated security key manifest as the configured security key manifest to contain data representing at least one of key size, key usage, key maintenance attributes, cryptographic algorithm used, subscriber identification data and authentication data for at least one subscriber. The subscriber obtains the configured key manifest and verifies the signature of the signed  
15 manifest as shown in Block 106. The subscriber also obtains the preexisting security credentials, such as the currently used key pairs or keys and their associated attributes. This is shown in Block 108. As shown in Block 110, the subscriber analyzes the manifest data (key attributes) from the preexisting security credentials. If there is a difference in key attributes for a given key pair or if there are new attributes for new  
20 keys, as shown in Block 112, the subscriber updates the credentials based on the difference data 30, such as generating new keys or removing keys from the credential set as shown in Block 114. If there is no difference between the configured security key manifest and the preexisting credential set, no action is needed as shown in Block 116.

25 As shown in Block 118, once new credentials are generated, they are stored to update the credential set for a given subscriber. Prior to using the updated key credentials, the subscriber receives a key criteria request as shown in Block 120, which may be, for example, a request from a software application to perform an operation such as e-mail or other operation. The key criteria request is used to determine the appropriate  
30 key or keys for a given application. For example, if an e-mail application is being used, the application will request that digital signature and/or encryption keys be used. As

such, the subscriber will then obtain the appropriate set of keys or appropriate keys based on the attribute usage data. As shown in Block 122, the subscriber analyzes the stored updated key attributes in the manifest to see if a key matches the key criterion in the request. This is shown in Block 124. If there is no match, the request is rejected as shown in Block 126. If there is more than one match as indicated by Block 128, the user is asked to select which key or keys to use as shown in Block 130. Alternatively, the subscriber may automatically select which keys to use based on default attributes. As shown in Block 132, if only one match exists between a key criteria request and the criteria data stored in the updated credential set from the configured manifest, the key is then used in the application. As such, the apparatus dynamically controls through a configured security key manifest the generation of a new security key for a subscriber based on the received key attribute data that was used to populate a configurable key manifest.

Referring back to FIG. 2b, the key pair manifest is a list of key pair records with each record containing information about a class of key pair attributes. A key class does not exist per key pair, but rather is differentiated from others by its unique set of attribute values. For example, there may be a long history of key pairs associated with a particular key class. Key classes are not typically distinguished by key usage. If there is a desire to have simultaneous DSA and RSA signing keys key pairs, for example, there may be an additional key class defining a key type as one to be used for RSA signing and a different key class indicating that the key type is for a DSA signing key. In addition, other attribute information might be data representing the content of associated public key certificates, such as validity periods and policy extensions.

Alternatively, the key manifest may be used to generate keys upon initialization. In this embodiment, there may not be pre-existing cryptographic security keys.

Also, it will be recognized that the invention or any suitable components therein may be embodied as hardware, software or any suitable combination thereof. If desired, the processes described may be carried out by a suitable programmed processor or

